IES Newsletter

Volume 9, Number 5
September-October 1992

Director's Note

Water is a renewable resource. Water vapor from evaporation and plant transpiration enters the atmosphere, condenses into clouds and returns to Earth as precipitation. Some of this water immediately cycles back into the atmosphere, some is taken up by plants, and the rest seeps into the soil or runs off into streams, rivers, lakes and oceans.

Water resources can be degraded by human activity: forestry and agricultural practices, for example, can lead to excess amounts of nutrients and pesticides. Eight of the Institute's scientific staff are doing research on aquatic ecosystems — streams, rivers and lakes — to learn more about what factors affect our waters, and what the potential impacts might be on these valuable resources. A major site for long-term IES research on aquatic ecosystems is the Hubbard Brook Experimental Forest in the White Mountains of New Hampshire (see page 3 of this newsletter). The cover story describes a recent project, in progress in relatively pristine lakes in northern Michigan.

The IES Newsletter is published by the Institute of Ecosystem Studies at the Mary Flagler Cary Arboretum. Located in Millbrook, New York, the Institute is a division of The New York Botanical Garden. All newsletter correspondence should be addressed to the Editor.

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Lakes as Laboratories

Ask someone, "Where do scientists do experiments?", and the likely answer will be "laboratories". If that individual knows a scientist who studies the natural world, he or she might add that field work — the collection of data at an outdoor site — is also an integral part of research. Few would guess that scientists occasionally have the opportunity, or the means, to experiment with whole ecosystems. This, however, is exactly what Institute ecologists Dr. Michael L. Pace and Dr. Jonathan J. Cole are doing ...

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People can affect lakes in at least two ways. First, they cause fluctuations in fish populations by fishing and by restocking. Second, human activities often lead to the input of nutrients[1] into lakes. These nutrients are released in the surrounding watershed from landscape destruction, forestry, sewage, and lawn and agricultural fertilizers, and carried to lakes through seepage, runoff and stream flow. What is the combined effect of these two types of human impacts on lakes, especially on the long-term dynamics of lake ecosystems? In order to learn more about this, and to make predictions about yet-unaffected lakes, Drs. Pace and Cole are collaborating with scientists from the University of Wisconsin/Madison and the University of Notre Dame, South Bend, Indiana on whole-lake experiments.

The four lakes that are the "laboratories" for this study are in a relatively remote area in northern Michigan, at the University of Notre Dame Environmental Research Center. The lakes are small, approximately 10 - 20 hectares each (25 - 50 acres), and relatively pristine, with no summer homes and no fishing. When the University of Wisconsin scientists conceived the project, they sought the expertise in microbial processes of Drs. Pace and Cole at IES. Research, supported by a grant from the National Science Foundation, began in 1991 and will continue through the 1995 field season, with the three research teams carefully controlling the fish populations and nutrient inputs on whole lakes in an experimental fashion.

During the 1991 and 1992 field seasons, the investigators set up experimental fish communities. In a narrow body of water — Long Lake — with basins at either end, they installed neoprene rubber curtains across the middle, thereby creating two lakes with identical water conditions. The other lakes in the study are Peter and Paul. Each of the four lakes already had natural populations of piscivorous (fish-eating) fish, but, because Peter and East Long were to represent lakes where over-fishing had removed the top predators, all bass and perch were relocated to other lakes. At the same time, planktivorous (plankton-eating) minnows were added to Peter and East Long, where, in the absence of predatory bass and perch, these smaller fish could be expected to thrive.

[1] *Nutrients are elements such as nitrogen, phosphorous, carbon and oxygen that are the raw materials for the growth and development of organisms.*

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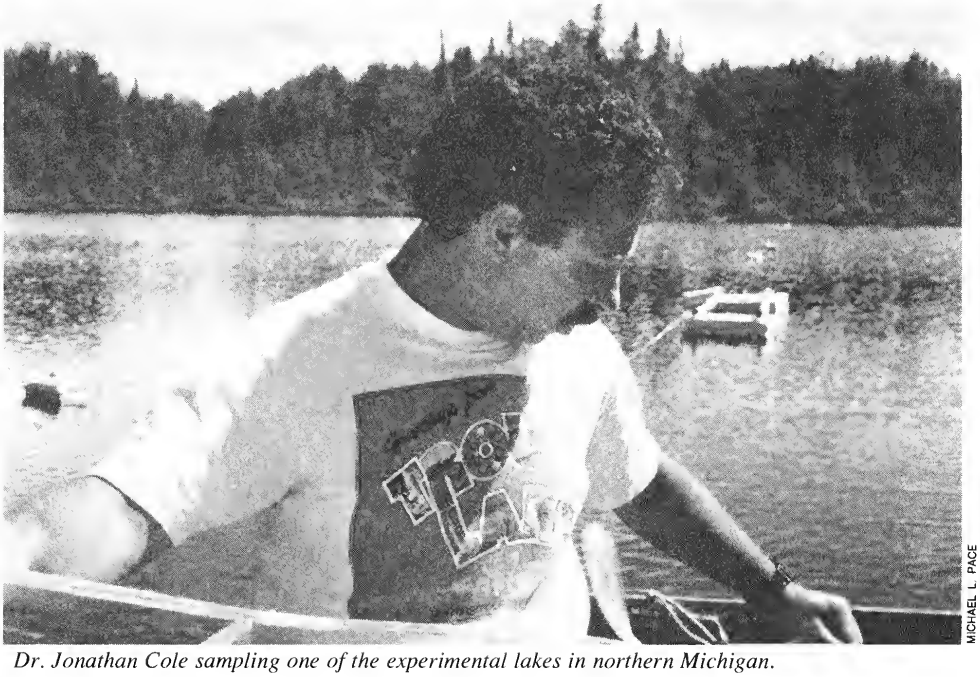

MICHAEL L. PACE

Dr. Jonathan Cole sampling one of the experimental lakes in northern Michigan.

Lakes, *from page 1*

The next phase of the study will be done during the field seasons of 1993-1995. The nutrients nitrogen and phosphorus will be added to Long Lake, whose two basins had the different fish treatments. Peter and Paul will not have nutrients added, and thus will serve as controls for the effects of different fish populations. When nutrient levels are increased in the waters of Long Lake, numbers of bacteria and algae are expected to show a corresponding increase, and the whole lake should turn green as a result. Interestingly, the scientists predict that East Long will turn green faster than will West Long. Why would this happen?

The prediction is based on the idea of a trophic cascade, "trophic" referring to nutrition and "cascade" suggesting movement from the top down. This term, then, describes how feeding behavior that begins at the top of a lakes' food web ultimately affects the organisms at its base. In West Long, bass will eat minnows, which will decline. The minnows' diet, zooplankton, consequently will thrive, especially the largest species. Finally, since larger forms of zooplankton graze most effectively on algae, their large numbers in this lake should hold in check the population of algae despite its tendency to explode after the addition of nutrients.

In East Long, the situation should be reversed. Here, with no predatory fish to limit their population, minnows will flourish and eat large quantities of zooplankton. Reduced numbers of these microscopic animal grazers will mean fewer controls on growth in algal populations, so East Long should turn green first.

Each of the three teams of scientists is concentrating on a part of the overall picture. Drs. Pace and Cole are focusing on how microorganisms, specifically zooplankton and bacteria, influence and are influenced by the changes made in the lakes' animal populations and water chemistry. In lakes with high amounts of nutrients, for example, the larger species of zooplankton have a tendency to stabilize the ecosystem until nutrient levels get very high. The Institute's ecologists hope to determine the "break point" at which lake ecosystems become unstable, and to learn more about what regulates microbial processes in general.

Early data suggest that, of the two parameters that are being changed, the addition of nutrients should have the greater impact on the lake ecosystem due to its direct effect on microbial growth. Changes in fish populations should have a weaker but still noticeable effect. When the study is completed, the collaborators hope to have answers to some of their questions: Can we predict the conditions leading to instability? What role is played by the food web in determining the break point? What regulates microbial activity in lake ecosystems? Findings from this bold whole-lake approach to answering questions about the functioning of ecosystems should provide ecologists and environmental managers with the basic knowledge needed for practical applications as well as for making predictions about interactions within other ecosystems.

Note: When the whole-lake study is finished, nutrients no longer will be added to East and West Long, and bass and perch will be restocked in Peter and East Long. Soon, the four lakes will have returned to their pre-study conditions.

Dr. Krischik Exchanges IPM Expertise

The importance of scientific findings is maximized when results are shared. This exchange of information can be through the publication of scientific papers and the presentation of research results at workshops and conferences, or it can be on a more personal basis, as simple as a conversation between two colleagues over a cup of coffee. Another way in which scientific information is shared is through international exchange visits. The goal of the Office of International Cooperation and Development (OICD), a division of the U.S. Department of Agriculture, is to provide opportunities for scientists to become involved internationally. With this goal in mind, the agency reviews and funds proposals that deal with scientific exchange, and it was to the OICD that Dr. Vera A. Krischik, Dr. Wendell E. Burkholder and Dr. Chen Shek Yu submitted a proposal for a visit to the People's Republic of China.

Each of these three scientists is an expert in different aspects of integrated pest management (IPM) techniques. Dr. Krischik, at the Institute under the auspices of a two-year National Science Foundation Visiting Professorship for Women, is an ecologist who recently developed the first how-to book for IPM, *Management of Grain, Bulk Commodities, and Bagged Products*. Dr. Burkholder, of the Department of Entomology at the University of Wisconsin, has worked on developing synthetic pheromones[1] and pheromone traps for 40 years. Dr. Shek Yu, a chemist at The Chlorox Company, developed a pheromone trap and IPM program for pests in commercial stores.

Integrated pest management is a multidisciplinary approach to controlling pests of plants or of stored grain and food products. IPM, developed around a knowledge of the ecology of the target pests, uses insects or disease organisms in conjunction with other management techniques to reduce the likelihood of pest outbreaks. Pests of field plants or stored grain are monitored using pheromone traps and controlled with biological control agents, insect disease organisms (e.g., *Bacillus thuringiensis*, which is commercially available for control of garden pests), natural desiccants and other means. An advantage of IPM, especially with regard to grain and food products, is that pests are controlled without the use of pesticides (except in the most severe infestations) so harmful residues in foods are avoided. (For more on IPM, see IES NEWSLETTERs November-December 1991: *The End of an Era in the Greenhouse*; and May-June, July-August 1992: *IES Notes*.)

China is an ideal choice for scientific exchange on natural methods to manage insect pests. Stable ecosystems lead to increased species richness, and, in the case of rice that has been grown in the same areas for 7,000 years, the increase has been in the numbers of biological control agents. The Chinese are long-time practitioners of IPM: over two thousand years ago they found that by keeping ants in citrus trees they could control attacks by caterpillars and boring beetles. Another of their early

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[1] *Many animals produce and secrete pheromones, chemicals that influence the behavior of other animals of the same species. Insects produce aggregation pheromones to attract both males and females of the same species and sex pheromones to attract a mate. When used in specially designed traps, these chemicals lure insects into an enclosure from which they cannot escape. Common examples of pheromone traps are the small yellow and green net enclosures seen hanging in local lawns — we cannot smell the natural chemicals that they contain, but Japanese beetles can ...*

Exchange, *from preceding page*

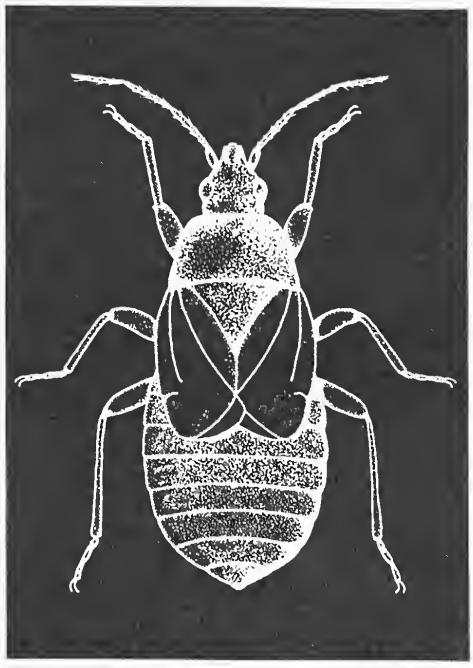
strategies involved the inundation of rice paddies with water to reduce pest outbreaks by drowning insects that pupate in the soil. The American scientists' goal in participating in a scientific exchange program with China was to learn more about IPM methods in that nation as well as to share their own knowledge and experience. Dr. Krischik's particular interest was to learn more about the use of predatory insects and of biological control agents, such as parasitic wasps, for killing grain pests. Also, she hoped to learn more about the long tradition among Chinese people of using native and medicinal plants not only to treat human ailments but also to kill insects.

The exchange visit was planned for the period directly following the 19th International Congress of Entomology, where Dr. Krischik chaired a session on the ecology of grain pests. On July 4, Drs. Krischik, Burkholder and Shek Yu were met in Beijing by Chinese officials from the Ministry of Commerce and started work the same day with a visit to a grain storage facility. Pheromone traps are the most effective way to search for pests in stored grain, and during visits to agricultural colleges and grain storage facilities in six cities the scientists demonstrated the use of these traps and left them in place for continued monitoring by warehouse personnel. After data are collected on the species composition and the size of the pest populations, appropriate control strategies can be implemented. The scientists also searched for biological control agents at the granaries, discovering a large predatory bug, unknown in the United States, in stored wheat, as well as a number of species of parasitic wasps. The Chinese hosts were asked to investigate experimentally how these insects attack local grain pests.

Chinese grain storage specialists shared their IPM experiences as well. Using perforated copper tubes to construct grain-probe traps modeled after traps given to them previously by Dr. Burkholder, they had experimented with the use of cracked grain and crushed locust tree beans as bait. (This use of locally available foods was a practical solution to the problem posed by a lack of the technology needed to synthesize pheromones.) The bait was placed at the bottom of the tube, and not only attracted insect pests to the trap but also helped keep them there.

The American scientists gave lectures about integrated pest management and participated in discussions with their Chinese counterparts at each site they visited. China places a high priority on having at least three months of food in storage, a necessary form of insurance in a nation of 1.3 billion people, and the U.S. team found that in general the grain storage conditions were excellent. Because the Chinese representatives are eager to learn more about the latest methods for insect detection and control, especially regarding the use of pheromone traps, plans were made for continued cooperation: a Chinese team will come to the United States in 1994.

The American IPM experts hope to be able to return to China, not only to take advantage of an apparent greater diversity of biological control agents there but also to visit universities with programs investigating the use of plant products for insect control. Findings about new parasites and predators and about plants and plant by-products as natural insecticides could have important applications to pest control programs in this country.



from: V. KRISCHIK

One of the good guys, the warehouse pirate bug (Xylocoris flavipes), *is a predator of insect pests in stored grain. While the number of potential biological control agents, like this one, is unknown, in the entire world there are only ten major species of the beetles and moths that are insect grain pests. Searching areas of the world where grains have been grown or stored for the longest periods of time should reap the greatest rewards in the search for biological control agents. Therefore, agricultural fields dating back thousands of years present the greatest opportunities for evolution of both pests and their predators and parasites.*

IES Notes

The Hubbard Brook Ecosystem Study was initiated in 1963 by Dr. Gene E. Likens (then with Dartmouth College and now director of IES) and colleagues. At the Annual Cooperator's Meeting on July 8-9, 1992, held at U.S. Forest Service Headquarters at Hubbard Brook, N.H., special events honored the retirements of three of the founding scientists: Dr. Robert S. Pierce (U.S. Forest Service); Dr. F. Herbert Bormann (Yale University) and Dr. Frank Sturges (Shepherd's College, W.Va.). Though retired from their respective institutions, they will continue to be active in Hubbard Brook research.

JOSEPH S. WARNER

l. to r.: Dr. Likens, Dr. Pierce, Dr. Bormann and Dr. Sturges with Dr. Richard T. Holmes, a professor at Dartmouth College who has been studying bird communities at Hubbard Brook since the mid-1960s.

Fall Calendar

CONTINUING EDUCATION PROGRAM
Winter and Spring Semesters

The winter semester begins in mid-January. Catalogues describing **classes, workshops and ecological excursions** offered during winter and spring will be available early in December. Call the number below for information.

SUNDAY ECOLOGY PROGRAMS

Free public programs are held on the first and third Sunday of each month, except over holiday weekends. Programs begin at 2 p.m. at the Gifford House on Route 44A unless otherwise noted. Call (914) 677-5359 to confirm the day's topic.

Dec. 6: **An Origami "Forest Ecosystem"**, an activity led by Jill Cadwallader
Jan. 17: A program for children led by Kass Hogan

• *For outdoor programs, dress for the weather conditions, with sturdy waterproof shoes. In case of inclement weather, call (914) 677-5358 after 1 p.m. to learn the status of the day's program.*

IES SEMINARS

The Institute's program of **scientific seminars** features presentations by visiting scientists. Free seminars are held at the Plant Science Building on Fridays at 3:30 p.m.

Dec. 4: **Host Nutrition, Resource Competition Between Host and Pathogen, and the Outcome of Infectious Disease,** by Dr. Val Smith, Univ. of Montreal
Dec. 11: **Rodents As Seed Consumers and Dispersers**, by Mary V. Price, Univ. of California-Riverside

The scientific seminar series will resume early in January 1993.

ART EXHIBIT

"Little Brother of the Sea" is one of the many nicknames given the Atlantic puffin. It is also the name of the collection of bird paintings and drawings by artist Karen L. Allaben-Confer that is now on exhibit at the Institute. This collection of wildlife art has been on tour for the past year, displayed at the Montshire Museum of Science, the QLF/Atlantic Center for the Environment, and ZooAmerica North American Wildlife Park. Works include the title piece, *Little Brother of the Sea*, paintings of other sea birds, sketches of owls, and collages illustrating the steps in the development of a finished work of art. The Institute is the final stop of the tour, and the exhibit will be open to the public through the end of December in the lobby of the Plant Science Building.
Hours: 9 a.m. - 4 p.m. Closed weekends, and on Nov. 26 & 27 and Dec. 25. Admission is by free visitor permit.
Note: Posters of the title piece are sold weekdays at the IES Education Program Office on the 2nd floor of the Gifford House. The cost is $15.

GIFT SHOP

Senior Citizens Days: On Wednesdays, senior citizens receive a 10% discount (except sale items).
Annual Pre-Holiday Sale: Friday, Saturday and Sunday, December 4-6 — members receive 20% off on gifts and plants, and 10% off on books.

ARBORETUM HOURS
(Winter hours: October 1 - April 30; closed on public holidays)

Arboretum grounds are open Mon. - Sat., 9 a.m. - 4 p.m.; Sun. 1 - 4 p.m. (Trails and internal roads are closed during deer hunting season.)
The **Gift and Plant Shop** is open Tues. - Sat., 11 a.m. - 4 p.m. and Sun. 1 - 4 p.m.
(Closed weekdays from 1 - 1:30 p.m.)

• *All visitors must obtain a free permit at the Gifford House Visitor and Education Center on Route 44A for access to the Arboretum. Permits are available until 3:00 p.m. daily.*

LITTLE BROTHER OF THE SEA

by Karen Lynn Allaben-Confer

GREENHOUSE

The IES greenhouse is a year-round tropical plant paradise as well as a site for controlled environmental research. The greenhouse is open during Arboretum hours. Admission is by free permit from the Gifford House.

MEMBERSHIP

Become a member of the Mary Flagler Cary Arboretum. Benefits include a member's rate for IES courses and excursions, a 10% discount on purchases from the Gift Shop, a free subscription to the IES NEWSLETTER, and parking privileges and free admission to the Enid A. Haupt Conservatory at The New York Botanical Garden in the Bronx. Individual membership is $30; family membership is $40. For information on memberships, contact Janice Claiborne at (914) 677-5343.

For more information, call (914) 677-5359 weekdays from 8:30 - 4:30.

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